PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

SATO ET AL

Application No.: 10/644,965 Art Unit: 1775

Filed: August 21, 2003 Examiner: Jason Savage

For: Multi-Layer Sliding Part and a Method for Its Manufacture

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Kenzou Tadokoro, declare as follows:

1. I am an employee of Senju Metal Industry, Co., Ltd, which is the assignee of the present application.

2. I am one of the inventors of the present application and of U.S. Patent No. 6,492,033 by Sato et al. That patent will be referred to below as Sato '033.

3. Sato '033 discloses a method of forming a lead-free plain bearing in which a Sn-Cu-Ag alloy powder is dispersed on a backing plate. The powder is then sintered to form a bearing

alloy layer on the backing plate. Molybdenum disulfide powder and/or graphite powder may be mixed with the Sn-Cu-Ag powder before sintering to improve the properties of the bearing.

4. In contrast, a bearing according to claim 4 of this application is formed by mixing a Cu-plated solid lubricant powder with a Cu-based alloy powder and performing sintering (initial sintering) of the mixed powder to form a sintered mass. The sintered mass is then pulverized to form a powder. This powder is dispersed on a backing plate. Sintering is then performed to bond the grains of dispersed powder to each other and to the backing plate. The step of initial sintering of the mixed powder and pulverizing the sintered mass results in a powder in which the solid lubricant is uniformly distributed.

5. One of my co-inventors is Hideaki Tanibata. We performed tests to compare the structure of a bearing prepared by the method of Sato '033 and a bearing prepared by the method described in claim 4. In the tests, a bearing was prepared by each method. The bearing prepared by the method of Sato '033 will be referred to as the comparative bearing. The bearing prepared by the method of claim 4 will be referred to as the inventive bearing.

6. The comparative bearing was prepared by the following steps:

(a) Dispersing on first side: A Sn-Cu-Ag alloy powder was uniformly dispersed on the first side of a steel backing plate.

(b) First sintering: The backing plate on which the powder was dispersed was heated to sinter the grains of powder to each other and to the first side of the backing plate. The sintering

formed a bearing alloy layer on the first side of the backing plate.

(c) Dispersing on second side: The same Sn-Cu-Ag alloy powder as in Step (a) was uniformly dispersed on the second side of the backing plate.

(d) Second sintering: The backing plate on which the powder was dispersed was heated to sinter the grains of powder to each other and to the second side of the backing plate. The sintering formed a bearing alloy layer on the second side of the backing plate.

(e) First pressing: Each of the sintered bearing alloy layers was pressed to densify it.

(f) Annealing: The bearing was heated in a heating furnace to carry out annealing.

(g) Second pressing: Each of the bearing alloy layers was pressed again to further densify it.

(h) Machining: The bearing alloy layers were machined to give them a suitable smoothness.

7. The inventive bearing was prepared by the following steps:

(a') Mixing: Cu-plated graphite powder was mixed with a Sn-Cu alloy powder to obtain a mixed powder.

(b') Initial sintering: The mixed powder obtained in Step (a') was sintered to form a sintered mass.

(c') Pulverizing: The sintered mass formed in Step (b') was pulverized to form a powder.

(d') Dispersing on first side: Pulverized powder formed in Step (c') was uniformly dispersed on the first side of a steel backing plate (same procedure as in Step (a) for the comparative bearing except for using a different type of powder).

(e') First sintering: The backing plate on which the powder was dispersed in Step (d') was heated to sinter the powder grains to each other and to the first side of the backing plate. The sintering formed a bearing alloy layer on the first side of the backing plate (same procedure as in Step (b) for the comparative bearing).

(f') Dispersing on second side: Pulverized powder formed in Step (c') was uniformly dispersed on the second side of the backing plate (same procedure as in Step (c) for the comparative bearing except for using a different powder).

(g') Second sintering: The backing plate on which the powder was dispersed in Step (f') was heated to sinter the grains of powder to each other and to the second side of the backing plate. The sintering formed a bearing alloy layer on the second side of the backing plate (same procedure as in Step (d) for the comparative bearing).

(h') First pressing: Each of the sintered bearing alloy layers was pressed to densify it (same procedure as in Step (e) for the comparative bearing).

(i') Annealing: The bearing was heated in a heating furnace to carry out annealing (same procedure as in Step (f) for the comparative bearing).

(j') Second pressing: Each of the bearing alloy layers was pressed again to further densify it (same procedure as in Step (g) for the comparative bearing).

(k') Machining: The bearing alloy layers were machined to give them a suitable smoothness (same procedure as in Step (h) for the comparative bearing).

8. A cross section of each bearing was observed under a microscope and photographed. A photograph of each magnified

cross section is attached. The photograph labeled "Cu-Sn-Ag" shows the comparative bearing, and the photograph labeled "Cu-Sn-Graphite" shows the inventive bearing. The top portion of each photograph is one of the bearing alloy layers and the bottom portion of each photograph is the backing plate. The large dark areas in the photograph of the Cu-Sn-Graphite bearing indicate particles of copper-coated graphite. The small dark spots in each photograph indicate voids.

9. The Cu-Sn-Ag bearing alloy layers contained a large number of voids. The Cu-Sn-Graphite bearing alloy layers were largely without voids and had a much more uniform texture than the Cu-Sn-Ag bearing alloy layers. The large decrease in the amount of voids and the more uniform texture were due both to the presence of the copper-coated graphite and to the step of initial sintering performed when manufacturing the inventive bearing. However, the initial sintering was a major factor, because if the same composition as was used for the inventive bearing is used to prepare a bearing without performing initial sintering, the resulting bearing will have a large number of voids. Therefore, if copper-coated graphite were added to the composition used for the comparative bearing and a bearing was prepared by the method used for the comparative bearing, the resulting bearing would still have a large number of voids.

10. These photographs show that a bearing manufactured by the method described in claim 4 of our application can be physically distinguished from a bearing manufactured by the method described in Sato '033.

11. The much lower amount of voids and the more uniform

texture of the inventive bearing compared to the comparative bearing provide the advantage that the withstand load of the bearing is increased because the density of the alloy which forms the bearing is increased.

12. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

Kenzou Tadokoro
Tokyo, Japan

Date: 27. Jun. 2006 Kenzou Tadokoro

Section structure of a multi-layer sliding part

Cu-Sn-Ag	Cu-Sn-Graphite